

Frostbyte Falls

Apple Computer, Inc. Technical Communications

AppleCD SC

AppleCD SC

Sue Goodin
Tech Comm Engineer



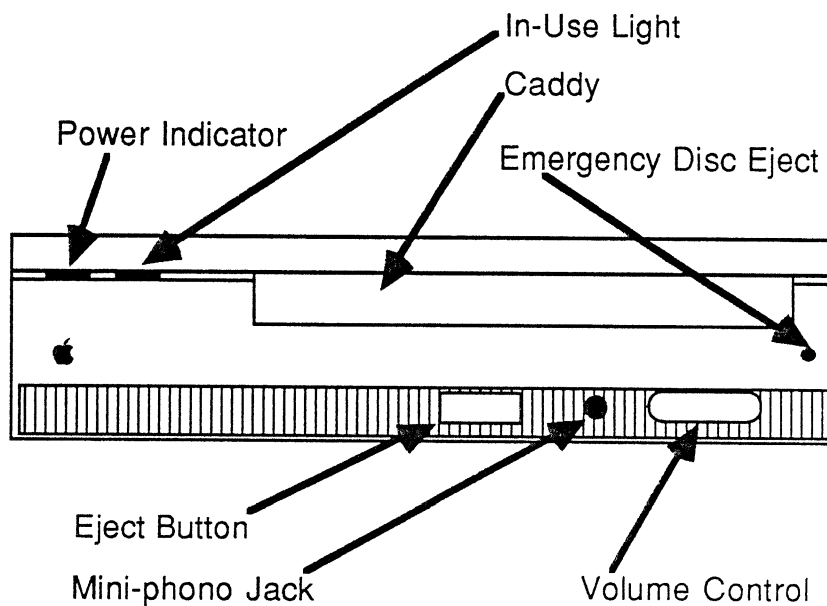
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AppleCD SC

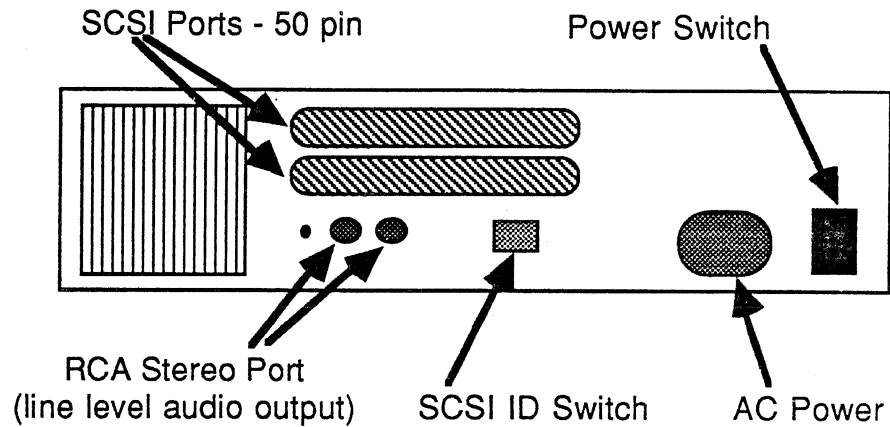
Overview

The AppleCD SC is an audio-capable CD-ROM (Compact Disk - Read Only Media) device with Apple SCSI ports. This peripheral device is about the same size as an Apple SCSI hard drive and reads compact discs with up to 550 Megabytes storage capacity. Apple will support CD-Audio, CD-ROM, HFS, ProDOS, and High Sierra formats for information contained on each disc. The product will be announced March 1 at Microsoft's CD-ROM Conference, and will ship in April at a suggested retail price of about \$1200.

The AppleCD SC has a front-loading caddy for standard-size compact discs. The player accommodates stereo headphones or speakers through either the mini-phono jack in front, or via the line level audio output ports in back of the device.



AppleCD SC - Front View



AppleCD SC - Back View

We are using "second-generation" CD hardware, which contains better error checking in firmware, a 64K RAM buffer, half-height size, better small-block handling capabilities, and better CD-Audio results than earlier CD-ROM players.

The product is expected to appeal to National Accounts, Universities, and any market that requires a mass storage device but has little need for data modification.

Throughout this document, we will discuss the characteristics of compact disc players and media, competitive storage hardware, and industry standards for data formats. We'll also look at Apple-specific issues, such as drivers and applications used with the AppleCD SC. The reference and specification sections at the end of this document is intended to direct you to further sources of information about compact discs.

What Can a CD-ROM Do?

A CD-ROM provides large-capacity read-only data storage with low-cost media duplication -- a very useful device for customer applications that fit these requirements. It can hold 550 Megabytes of data - enough for about 250,000 pages of text, 20,000 line drawings, or 2,000 high-resolution drawings. Some applications of this medium might include: a history of stock market prices; catalogs of service parts and costs, including graphic illustrations; NASA satellite photos and maps; and training materials.

The compact discs themselves are sturdy, unaffected by magnets, and can be removed from the player for data security.

A CD-ROM is not appropriate for all Apple customers; it is therefore helpful to understand the background and variables behind CD-ROM capabilities, media preparation issues, and proposed optical media standards.

CD-ROM Theory of Operation

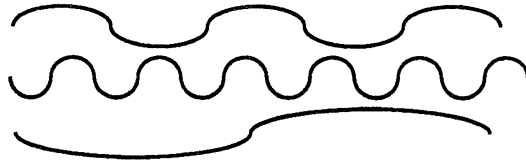
A compact disc player uses a laser to interpret a disc's "pits" and "lands". Data stored on the media may be organized in various formats. In this section we'll look at the role the laser, physical data representation, and media organization play in the compact disc market.

The Laser

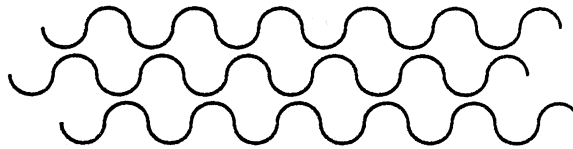
The heart of a CD-ROM is a gallium arsenide laser that resides in the bottom of the disk drive. Lasers are becoming a more common device as technology advances - Apple also uses lasers in its laser printers.

A laser (an acronym for Light Amplification by Stimulated Emission of Radiation) is generated by a pure chemical substance when its molecules are excited by external forces. All electrically stimulated atoms will emit light, but a mixture of substances will result in a variety of resultant wavelengths. Because a laser uses one chemically pure compound, it emits light of one coherent wavelength.

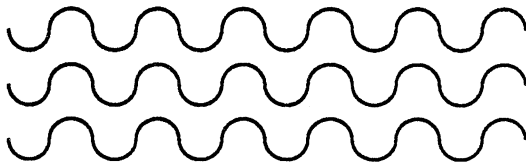
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White light
Varied wavelengths



Light of a particular color
One wavelength - Out of phase

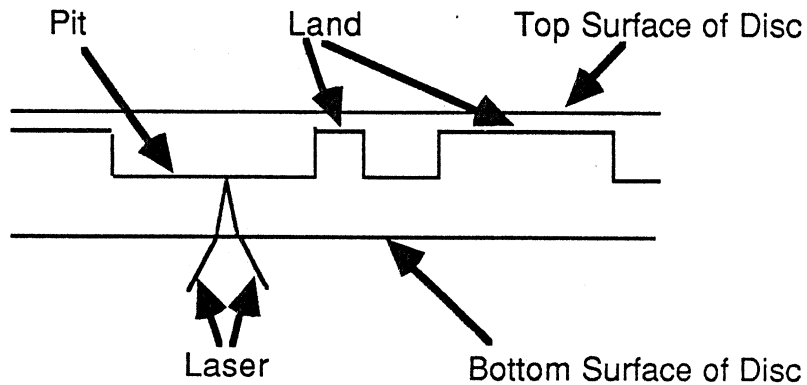


Laser (Coherent light)
One wavelength - In phase

Representations of light wavelengths

The coherent wavelength property is inherent in all laser uses. Because the peaks of each wave instance coincide, the resultant amplitude is the sum of all waves. Another result of the superimposed waves is the assurance that all wave "peaks" and "troughs" will arrive at a destination at the same time. This makes it easier to direct and read light reflections or to polarize other material.

The potential power and accuracy of this light can be harnessed for use in surgery, manufacturing, and surveying, for example. The LaserWriters shine the laser onto the printer's drum at 300 dots per inch accuracy. A compact disc player can accurately direct the laser's light toward microscopic-sized variations on the media.

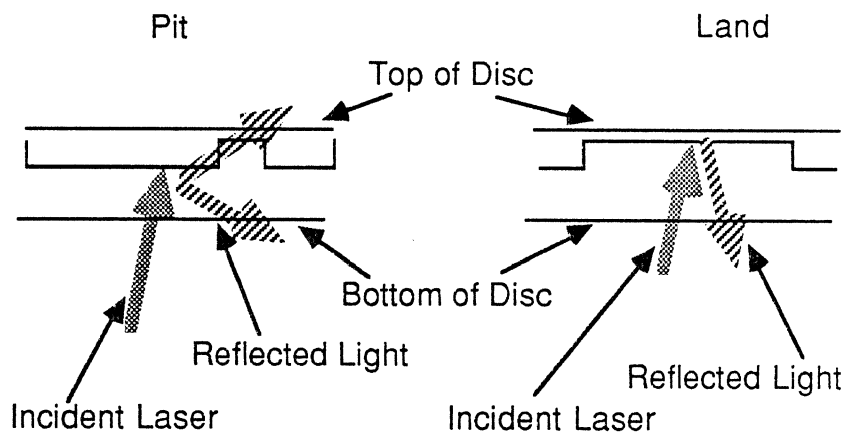


Data on a compact disc

To read a compact disc, the laser shines through the CD, is refracted by the closer (bottom) surface of the media, and is reflected by aluminum spattering on the inside of the far surface (top) of the disc. The compact disc's circuitry then reads the amount of reflected light to determine the data represented by the media.

Pits and Lands

Data is represented on the disc by a collection of "lands" (flat spots) and "pits" (bumps) on the inside of the top layer of the disc. Lands reflect the laser such that the reflected wave returns to the laser's source. Pits scatter light in many directions, so very little reflected light is received at the source.



Laser on Compact Disc Pits and Lands

The CD-ROM's firmware compiles pits as data bit "1", and land to data bit "0". The series of bits are converted into

logical bytes, the results are compared with error checking bytes, and the information is returned to the host computer.

The Media

Note that the technique used by CD players is such that the disc's label is never crossed by the laser beam; therefore, the top side of the disk can be decorated in any way the manufacturer desires. The vital data on each CD is on the inside of the disk and is protected from scratches, small bits of dirt, etc. Therefore, the media does not require the same protection as a floppy disk.

Data on a CD-ROM is encoded on one long spiral. When a compact disk searches for a sector of data, it must follow the spiral until it finds the proper portion of the disc. As a result, compact discs have an inherently slow seek time.

Data on a CD is read at a constant linear rate; the CD player must rotate the disk at varying rates of speed, depending on the distance from the drive's head to the center of the disc. This technique, similar to the one employed on Apple's 3.5-inch floppy drives, is called Constant Linear Velocity (CLV).

Comparisons to Other Storage Media

As a mass storage device, compact discs will be compared with other optical media and existing hard disks. The short descriptions below will help you compare the CD-ROM to other potential mass storage purchases. The features of each technology are summarized in a table at the end of this section.

CD-Audio

The CD-ROM has been developed from the CD-Audio platform. However, due to the nature of the data, the CD-ROM requires a more accurate and reliable hardware engine. Digital data is three times more sensitive than audio data; if several bits of audio data are unreadable on a CD-Audio disk, the firmware can interpolate the data from surrounding information with little-to-no discernible loss of accuracy.

Of course, such interpolation is not acceptable for computer data. The CD-ROM possesses more sophisticated error detection and correction in its firmware, and greater amounts of cyclic redundancy checking (CRC) are used on CD-ROM discs. This accounts for the difference in cost between CD-ROM and CD-Audio technologies. Nevertheless, the basic theory behind the two CD engines is the same. In fact, it is due to the success of the CD-Audio player that CD-ROM players have been developed relatively quickly.

WORM Drives

WORM disks (Write Once Read Many) use removable optical media that can be written to only once. WORM drives also use a laser within the engine, but the media shares no common characteristics with compact discs. If WORM data is to be modified, the file must be written to the disk again in a new location. The directory must also be updated, and that portion of the disk with the original file and directory may not be reused.

WORM disks typically hold about 650 Mbytes of data (325 Mbytes on each side) and cost about \$150.00 (retail price) for each disk, so the cost per megabyte of data is generally more expensive on WORM than compact discs. However,

because WORM can use two sided discs, it offers a larger storage capacity, and has the ability to modify data.

Laserdisks

Laserdisks also use optical technology, but they store video information in analog form rather than as digital information. Sound on laserdisk is supported in either digital or analog form. There is currently no standard laserdisk format for storing digital data. Like compact disc, the laserdisk uses read only media.

Laserdisks have not enjoyed the success that is predicted for CD-ROM discs, even though they have been produced for a longer period of time than compact discs. They have received heavy competition from video tape storage, which has similar capabilities, but permits the user to record his own data.

Pioneer is the leader in laserdisk production - their products are most frequently used in home video applications.

Hard Disks

Most computer users now use a hard disk for mass storage of data. A CD-ROM can expand storage capacity by, typically, a factor of 10 to 20. And, since the media is ejectable, the potential for accessing multiple data bases, clip art libraries, etc., is even higher. However, a CD-ROM disc's data transfer rate is about 10 times slower than a hard disk, so applications that are timing sensitive, or that require fast data transfer may not be appropriate for a compact disc. In particular, animation from CD media is unsatisfactory due to the slower access time.

	Capacity (bytes)	Transfer rate (bps)	Seek time	Eject media	Cost (\$)
CD-ROM	550 M	150K	500 ms-1 s	yes	1000
Hard Disk	20-600 M	800K	30-100 ms	no	1000
Floppy Disk	800 K	100-300K	200 ms	yes	400
WORM	325 M/side	500K	100 ms	yes	5000
Laserdisk	800 M -1G	800K	150 ms	yes	1000

Comparison of Mass Storage Media

How are CD-ROM disks made?

There are two methods of obtaining data on CD-ROM discs: the customer may purchase a commercially available disc, or the user may prepare discs for limited distribution within a market or company. If the user wishes to produce a disc, the process includes several steps. These are: collect and organize the data, add error detection information (called premastering), create a disc master, and finally, duplicate user discs.

Collecting and Organizing Data

The first step in producing a CD-ROM disc is to collect the information to be included on the disc. The user must then test the data using an appropriate computer application, and organize the data in a manner that will be most useful to them. At this point, the customer should determine the file structure (the number of folders, file placement, etc.) that will be most satisfying.

Apple computer users are likely to find one or more hard disks to be the medium of choice for this task, although it is desirable to use other techniques when an accurate representation of CD-ROM rate of data transfer is needed.

Meridian Data's product "CD Publisher" has been developed to meet this need. CD Publisher consists of a hard disk which simulates a CD-ROM by running at a slower speed upon request.

Some users find that a WORM disk is useful for gathering and testing data. The high capacity and relatively slower speed of a WORM drive is similar to compact disc performance. Of course, it may be necessary for the user to use several WORM disks, at an additional cost for each disk, before data organization is final.

Premastering

After data collection and organization is complete, error detection and correction information must be added, and the disc sectors must be arranged properly for the chosen disc and file format. CD-ROM manufacturing companies will perform this premastering task for the customer, or the user may choose to purchase the equipment needed to calculate

and insert error checking and sync bytes and directory information.

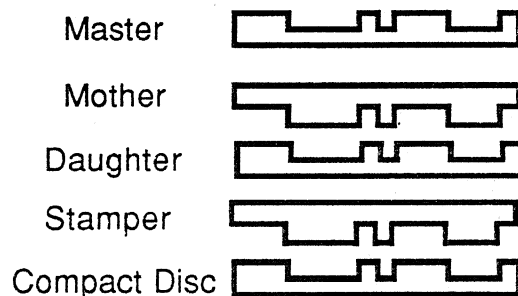
CD Publisher's companion software will support several compact disc file formats and will premaster the data accordingly.

Apple's product management and marketing groups are working with CD-ROM publishing houses to encourage them to accept Apple II or Macintosh hard disks as input for the CD production process. However, this is not the common means of transfer; most CD production houses will ask that information be sent to them on nine-track tape.

Meridian Data once again has an answer to this dilemma: CD Publisher's accompanying tape deck has a capacity of from 600 Megabytes to 2.4 Gigabytes.

Mastering

Once the information is received by the CD manufacturing house, and all error checking and sync bytes are added, a large laser beam writes the prepared data to a slowly rotating glass "master" disk covered with photo-resist. After the master is developed, it contains the encoded data on a spiral track which is about three miles long! One radius of the disc crosses the single track 200,000 times; the paths are 1.6 microns apart and each is 0.6 microns wide.

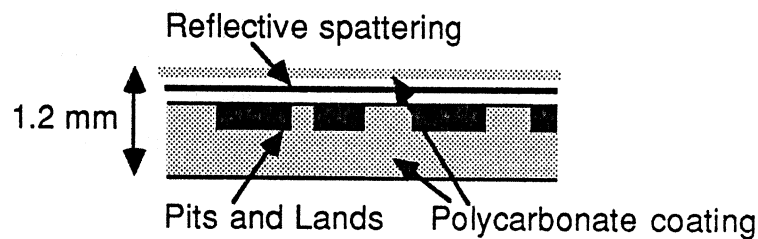


Producing a Compact Disc

The master is used to create a small number of nickel "mother" discs. Mother discs are negatives of the master, and are in turn used to create enough "daughter" disks for the expected production run. The positive daughter discs are used to create stampers, from which compact discs are produced through injection molding.

Pressing Discs

The molded discs receive a thin layer of aluminum or silver spattering above the data track to provide a reflective surface for the laser beam. The discs are protected with a hard polymer coating over the spattering, and are finished with a label on top.



Cross Section of a Compact Disc

CD production houses typically finish disc manufacturing by inserting the compact disc in a plastic "jewel case" to provide disc protection.

Costs

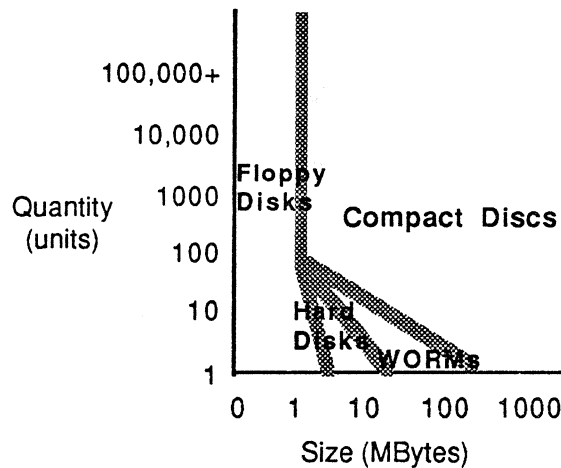
The process of creating a master is the bulk of CD-ROM disc production cost - it ranges from \$3,000 to \$7,000. Once the mastering is completed, however, each disk can be pressed for about \$2.00. The production cycle becomes economical, then, for companies requiring large amounts of data (say, over 30 Mbytes), and large quantities (more than 100) of the media. The costs of mastering may also be offset if a CD-ROM will reduce on-line time for remote computer access, or reduce other data distribution costs.

	Capacity (bytes)	Cost for media (\$)	Cost/ MByte (\$)
CD-ROM	550 M	5.00	0.01
Hard Disk	80M	1000.00	12.50
Floppy Disk	800K	2.00	2.50
WORM	800M	100.00	0.13

Mass Storage Media - Cost Comparison

The chart below gives an indication of a likely media choice based on quantity needed and amount of data to be stored. Other factors (such as ease of shipment, security requirements, data transfer rate, and current costs) also

enter into the customer's choice, so use this chart only as an initial selection guide.



CD-ROM Formats

The CD format industry is still in the process of sorting out the format issue. Since the industry is fairly new, there are a number of proposals from various companies and groups, and others will undoubtedly be forthcoming. The AppleCD SC supports several types of disk formats; we'll look at these, and other leading contenders for industry acceptance.

Red Book

The first standard developed in this industry is known as the Red Book standard. It was proposed by Philips and Sony, and describes the CD hardware, form factors, and media specifications. Today the Red Book is followed throughout the industry for CD-Audio. It also forms the basis for other standards discussed below.

The Red Book defines the way bit patterns are written to the compact disc, provides for synchronization bytes, and supports error correction within each "frame", or packet, of data. The overhead needed to accomplish this means that each frame, which represents 192 data bits (24 bytes), requires 588 channel bits on the compact disc.

Sync Pattern	27	27	channel bits
Control and Display Byte	17	17	

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12 Data bytes	$12 * 17$	204
Error Correction bytes	$4 * 17$	68
12 Data bytes	$12 * 17$	204
Error Correction bytes	$4 * 17$	68
	===	
Total	588	channel bits
Total data bytes	24	

A Compact Disc Data Frame

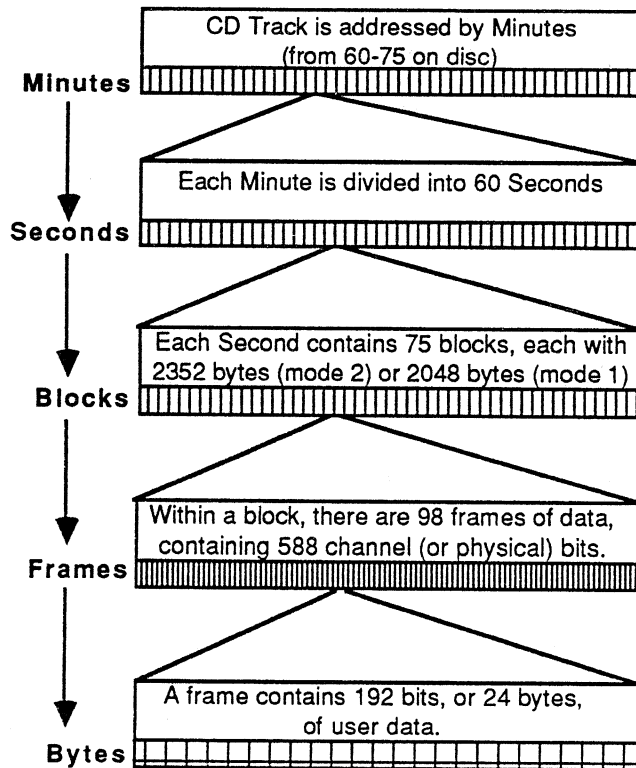
The CD-Audio data correction algorithm is called the Cross Interleave Reed-Solomon Correction (CIRC) method and is intended to correct large runs of data that may be unreadable due to laser error or a defective or scratched disc. In this process, frames are interleaved and error checking is performed on the sum of this data. Error bursts of up to 450 data bytes in length can be corrected using this technique. CIRC recovery used on compact discs results in an observed error rate of less than 1 in 10^{12} bits, or one unrecoverable error in 2000 discs.

CD-Audio reads digital sound samples at 44.1 KHz per second. With 16 bits per sample and 2 channels, the player reads 1,411,200 bits per second. Compact discs are capable of storing up to 75 minutes of sound per disc, although 60 minutes is frequently quoted as a common CD-Audio capacity.

Yellow Book

Philips and Sony again collaborated on the Yellow Book standard. This standard defines CD-ROM data addressing and supplies a richer error detection and correction algorithm than is found on CD-Audio.

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Compact Disc Logical Data Organization

CD-ROM data is organized into blocks with 98 24-byte frames in each. Of the 2352 data bytes in each block, 2048 bytes, or 2 Kbytes, is user data. The compact disc player reads 75 blocks each second. At 75 minutes of playing time (the same as CD-Audio), the CD-ROM can hold 660 Mbytes of data. As before, however, 60 minutes is generally used as the standard capacity, which equates to 550 Mbytes of CD-ROM data per disc.

	data bytes/ block	blocks/ second	minutes/ disc	Mbytes/ disc
Mode 1	2048	75	60	553
Mode 2	2352	75	60	635
		75	793	

Data capacity of a CD-ROM

Additional error detection and error correction (EDC/ECC) defined by the Yellow Book provide extra accuracy on CD-ROM discs. Each 2K data block is accompanied by 276 bytes used in a second layer of CIRC. Together with the Red Book's first layer of error correction, the algorithms

result in an undetectable error rate of only 1 bit in 2 quadrillion (10^{15}) discs.

High Sierra

In 1986, Apple was one of a number of interested parties that gathered at the High Sierra hotel in the Lake Tahoe area to come to a agreement on CD-ROM file formats. The result was a proposal, known as the High Sierra standard, which defines a hierarchical file system to be used on a CD-ROM.

Because all major CD technology companies were represented at High Sierra, and because the standard adds an element of organization to a previously fractured industry, High Sierra has found wide acceptance in the developer community. It is estimated that from 85 to 90 percent of all new CD-ROM titles are pressed in High Sierra format.

The High Sierra file system is written with compact disc characteristics in mind. For example, it does not include instructions to delete or write to files, since compact discs are read-only media. High Sierra also addresses the relatively slow seek time of the compact disc by specifying a path table on each volume. When a host computer requests a file from a High Sierra CD, a single seek will give the location of the disc's file, no matter how deeply it may be buried in nested folders. This directory may also be cached within the CPU, so that the host computer can immediately request the compact disc player to move to the file on the CD.

High Sierra is CPU-independent, so that a disk pressed with information conforming to High Sierra, could be conveniently read on Apple II, Macintosh, IBM PC, and other computers. All essential file data is written in palindrome format - that is, data is written twice: once as "high byte, low byte", and again as "low byte, high byte". Note that High Sierra discs are limited to no more than eight levels of "folders", and file names of no more than 31 characters.

Green Book

The Compact Disk Interactive (CD-I) format, also known as the Green Book standard, specifies a file and directory

structure that sits on top of both CD-Audio and CD-ROM, and is compatible with High Sierra. This Philips definition is actually a proposal for a 68000-based computer with compact disc drivers and file structure resident. There are currently no CPUs on the market that comply with CD-I, nor does the AppleCD SC support this standard.

CD-I supports compressed video, color representations in both RGB and CLUT modes, and screen wipes. Philips intends for CD-I to be versatile enough to store compressed video and audio, High Sierra data integrity, and 68000 code. Its operating system, CD-RTOS, is based on OS-9, with extensions for graphics and audio support.

Compact Disc - Video

Philips and Sony use the Compact Disc - Video (CD-V) definition for full-motion video on NTSC. A few CD-V drives are on the market now. They support 200 Mbytes of CD-ROM information and five minutes of full-motion video in Laserdisk format. CD-V discs now being sold are generally rock videos.

Other Formats

Industry companies interested in extending the compact disc market have proposed other standards.

RCA is promoting Digital Video Interface (DVI), which can play a full hour of video on CD at 30 frames per second. DVI supports CD-ROM, but DVI compatibility requires the full chip set from RCA and GE. It is likely that RCA will make further announcements about DVI at the Microsoft CD-ROM Conference this year.

Compact Video Disc (CVD) from SOCS Research is a full-motion video definition for the consumer market. This proposal has yet been embraced by the CD industry, and CVD is simply another paper proposal at this time.

Other types of compact disc structures have been used by individual developers. These formats are generally one-of-a-kind, and must be supplied with a custom driver to permit the host CPU to recognize them. Fortunately, unique formats are becoming fewer, now that the above-mentioned

standards (in particular, High Sierra) are more widely accepted.

The AppleCD SC

The AppleCD SC does a full-stroke seek and read in 500 milliseconds; its mode transfer rate is 154 KBytes per second. The hardware is capable of recognizing three compact disc data modes: mode 1 (with a 2048-byte data block size) mode 2 (with 2352-byte data blocks) and audio. Since Apple CPUs request 512 byte data blocks, and our drivers interpret the data correctly in either case, the differences between mode 1 and mode 2 are indistinguishable to the user.

The player has a 64K internal RAM buffer and a SCSI interface which satisfies IEEE and Apple SCSI standards.

Unlike CD-Audio players, which typically play a disk from one end of the spiral to another, a CD-ROM must be prepared to quickly search the track for requested data. The AppleCD SC's mechanical assembly is designed for heavy random access.

Accessing the AppleCD SC

The AppleCD SC and accompanying software will conform to Red Book, Yellow Book, and High Sierra standards. If a third party application includes calls directly to the Macintosh Driver Manager or to ProDOS, unique compact disc formats may also be read. Apple has no plans to implement support of other formats.

The Apple II Family

An Apple II user who wishes to use the AppleCD SC must have an Apple II SCSI Card with at least a revision C ROM. The card's ROMs have been revised to support read-only media and devices with more than 32 Mbyte capacity. Our Singapore manufacturing facility is cutting over to the newer ROM, and revised product should be received in the U.S. by March 15. Customers with revision A or B SCSI Card ROMs may receive an update from their service provider at no charge. Details on the implementation of this exchange will be sent to Apple dealers in the March service mailing.

The AppleCD SC User's Guide indicates that the recommended position for the drive on an Apple II is at the end of the SCSI chain. This situation will minimize the likelihood of the following scenario:

The customer has a SCSI device that permits ejectable, partitioned media (e.g., a compact disc, cartridge hard disk, tape backup). If the media in that device is ejected and replaced with media which has more partitions than the first, ProDOS 8 will reassign logical volume IDs to the new media, and all SCSI devices past it on the SCSI bus. ProDOS 8 cannot handle the volume number changes elegantly, and may cause applications to become confused about the location and availability of SCSI volumes. Because a compact disc is likely to be partitioned to overcome the 32 Mbyte limitation of ProDOS 8, putting the CD at the end of the chain will limit its effect on other SCSI devices. Future versions of ProDOS will address this situation properly.

The eject button on the AppleCD SC will operate on all types of compact discs used on an Apple II. As usual, if an application expects the volume to be on-line and the disc is ejected, ProDOS will ask the user to insert the disc.

Once the Apple II hardware is up-to-date with rev C ROMs, the customer may access a compact disc that uses either audio, ProDOS, or High Sierra format with the appropriate Apple-supplied driver.

The AppleCD SC's accessory kit contains a version of CD Remote for both the Apple IIe and Apple IIGS. To play an audio CD from an Apple IIGS, copy the file CD.AUDIO from the Apple II disk supplied with the AppleCD SC to the DESK.ACCS folder on the Apple IIGS startup disk. On the Apple IIe, the user must run the Apple IIe CD Remote program included with the AppleCD SC package.

A compact disc pressed in ProDOS format will be recognized by either ProDOS 8 or ProDOS 16, and used accordingly. ProDOS 8 retains its 32 Mbyte limitation, so compact discs are likely to be partitioned if they are intended to be used on an Apple IIe. ProDOS 16 is not limited to 32 Mbyte volume sizes.

The High Sierra driver for the Apple IIGS will be available later this year. Once this driver is placed within the System Folder under ProDOS 16, the Apple IIGS will recognize a High Sierra disc as a storage device, just as it recognizes hard disks.

The Apple IIe does not support ProDOS 16, and therefore, cannot take advantage of the Driver folder structure within the System Folder. Apple will supply interested developers with the High Sierra driver, which must then be incorporated into each application that supports High Sierra formatted discs on the Apple IIe. With these Developer Tools, High Sierra discs with over 32 Mbytes of data don't need to be partitioned to be used under ProDOS 8.

The AppleCD SC's 64K buffer will be particularly useful when the player is connected to an Apple IIe, because the disc feeds data faster than the Apple IIe can handle the information. With an Apple IIGS, the speed of the CPU and compact disc compare favorably, so that the user will not notice lag time when accessing a CD file.

The Macintosh Family

Any Macintosh capable of SCSI support can be connected to the AppleCD SC using an appropriate SCSI System or Connector cable and terminator(s). Of course, the SCSI ID

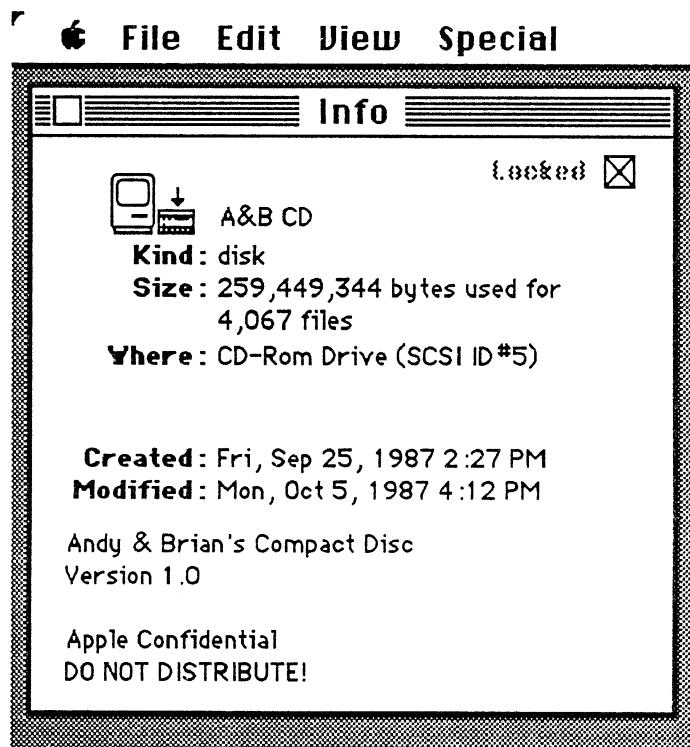
on the drive must be set to a unique number within the CPU's SCSI bus.

The AppleCD SC will be recognized by the Macintosh Operating System with only minimal additions to the boot disk's System Folder. The Macintosh disk shipped in the AppleCD SC accessory kit includes 1) the CD Remote INIT, 2) the AppleCD resource, and 3) the CD Remote desk accessory. These files may be placed in the boot volume's System Folder with the supplied Installer Script, or they may be copied as instructed below.

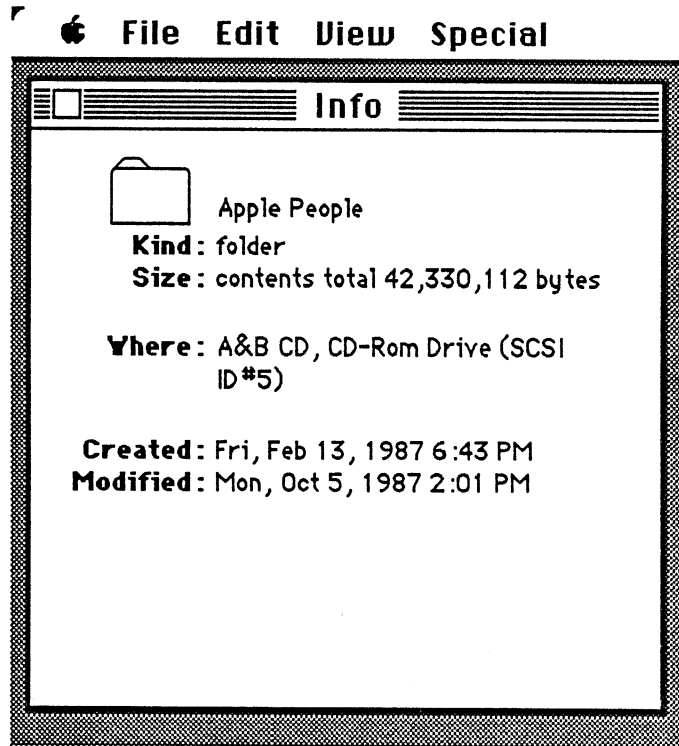


Icon of HFS Compact Disc on desktop

Once the AppleCD resource is copied to the System Folder, a compact disc formatted as a Macintosh HFS volume will be mounted on the desktop, and can be accessed just as any HFS media. Files on the CD can be opened, copied, etc., but cannot be thrown away.



Get Info for an HFS compact disc



Get Info for a folder on a compact disc

The AppleCD SC Eject button does not operate when a Macintosh HFS compact disc is inserted; to remove the media, drag the disc's icon to the Trash.

To play CD-Audio discs on the AppleCD SC, the user must place the CD Remote INIT icon in the System Folder of the boot volume, and use Mover to install the CD Remote desk accessory in the System.

A Macintosh High Sierra INIT will begin to ship with the AppleCD SC early this summer. Support for this format depends upon the availability of the Macintosh External File System (XFS). Once the Macintosh Operating System is capable of passing along foreign commands to another file resource, the High Sierra extensions will accept these instructions, fetch the information from the compact disc, and return the results to the Macintosh OS. The user will "see" the High Sierra formatted disc as another Macintosh volume on the desktop, and will have available all Macintosh volume operations (except writing to the disc). The Eject button on the CD hardware will not be operational on any type of disc format (including High Sierra and Audio formats) while XFS is active.

The AppleCD SC does not currently support A/UX access.

When using an AppleCD SC with a Macintosh Plus, the speed of the drive is comparable to the speed with which the CPU can accept data. However, Macintosh SE and Macintosh II users will notice the slower access time compared to that of hard disks on those CPUs.

CD-Audio Control

To play a CD-Audio disc from any Apple CPU, first install the appropriate CD Remote desk accessory or application as described above. Then insert the chosen audio compact disc into the AppleCD SC caddy, and put the caddy into the player.



Macintosh CD Remote - Default Settings

Click on the "play" button to begin playing the CD through the compact disc's speakers. Select songs with the "tracks" and "scan" arrows. Using the "Program" button, the user can select a sequence of songs, or can "shuffle" the songs in a random order. Selecting "Repeat" will cause the CD to begin again when the last track is done. Audio channels

may be individually controlled with the left and right speaker buttons.



Macintosh CD Remote - With User Selections

The AppleTalk Network

AppleShare 2.0 will support an AppleCD SC from a Macintosh server, where it can be accessed by any CPU on the network. Make sure that the AppleCD resource is installed in the server's System Folder. Then set up the server as usual with the AppleCD SC as a mounted drive.

What comes in the Box?

The AppleCD SC package includes the compact disc player (of course) and an accessory kit. Within the accessory kit, the user will receive a disc caddy, a ProDOS formatted 3.5-inch disk with appropriate drivers, a Macintosh floppy disk with the above-mentioned resources, and a compact disc with sample files and programs.

The sample CD will be partitioned for Macintosh HFS and ProDOS access. Apple plans to include HyperCard stacks with digitized pictures and sounds on the disc. This CD will begin to ship when the High Sierra extensions are ready.

NOTE: The sample CD will not be discussed at product introduction in March - it will be added to the package as an extra value later this year. Early purchasers of the AppleCD SC will receive a coupon in the box that will entitle them to the sample CD and High Sierra drivers when they become available.

Application Issues

The CD-ROM characteristics discussed here will lend themselves to reference applications popular on compact disc. But to gain acceptance among the user community, the corresponding CPU application (or, retrieval engine) must retrieve this data quickly and accurately. Various means are typically used to search the media.

- *Full-text search*, which is thorough but slow, and frequently returns superfluous information.

- *Hypermedia* allows for more free-form lookup, but requires more data preparation prior to pressing the CD media.

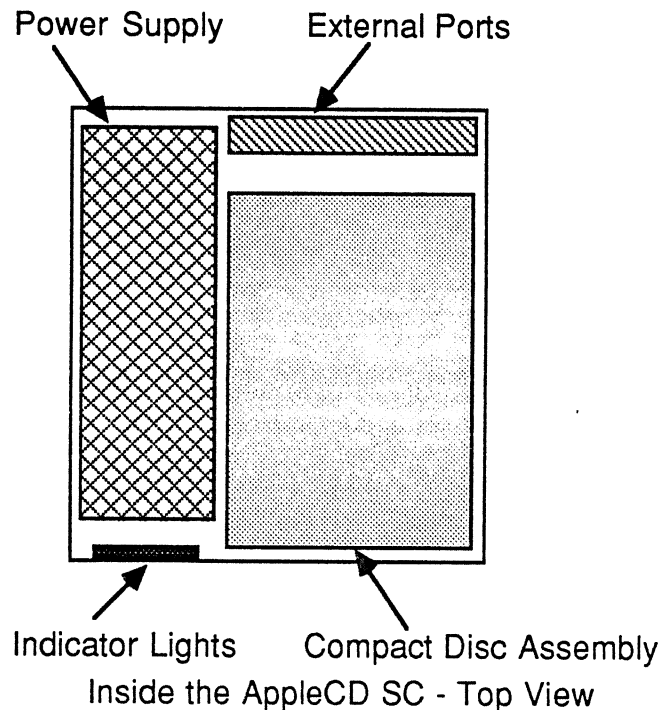
- The retrieval engine may use a *query language* or *data base application*. In this case, the user will need to "program" a query (ala 4th Dimension or Omnis) to access the information.

Certainly HyperCard will encourage Apple Macintosh developers to consider the hypertext format, since then the Macintosh interface is already prepared. Apple's evangelism and marketing groups are working with prospective CD developers to combine HyperCard and the AppleCD SC properly.

Apple will revise HyperCard to support the compact disc. HyperCard 2.0 will support locked devices, so that stacks can be written to access text, graphic, sound, or other types of data found on a CD. Apple will begin to ship version 2.0 this spring. It will be a free upgrade to all existing HyperCard owners.

Service Issues

The AppleCD SC contains four main components - the power supply, indicator light assembly, external port assembly, and the compact disc assembly. The player's top case and each internal component is secured with plastic tabs, so that only a flat-blade screwdriver is needed to disassemble the unit.



Service providers will be able to order exchange parts later this spring, when the AppleCD SC begins shipping. The following components will be available: compact disc mechanical assembly, fan assembly, power supply, LED board, and the rear audio board. No adjustments will be included in Apple Service Procedures.

Introduction Plans and Marketing Issues

The AppleCD SC will be introduced on March 1st at the Microsoft CD-ROM Conference in Seattle. This annual three-day conference is the compact disc industry's major gathering, with all important compact disc vendors and developers in attendance. Apple will host a Developer's Conference on March 4th in Seattle to encourage interested parties to develop compact discs appropriate for the Apple II and Macintosh environments.

References

Meridian Data
4450 Capitola Road
Suite 101
Capitola, CA 95010
408-476-5858

*Manufactures and Sells CD Publisher, provides
premastering services*

Reference Technology Inc (RTI)
1832 North 55th Street
Boulder, CO 80301

CD-ROM service bureau

Philips and DuPont Optical Company (PDO)
1409 Foulk Road
Wilmington, DE 19803-0469
302-479-2500
800-433-DISC

CD-ROM premastering and duplication

ARC (formerly LoDown)
10 Victor Square, Suite 200
Scotts Valley, CA 95066
408-438-7400

*CD-ROM premastering and duplication, SCSI CD and
WORM drives*

Optical Media International
314 Quail Run Road
P.O. Box 2107
Aptos, CA 95003
408-688-7521

*CD-ROM premastering and duplication for Macintosh and
Apple II*

Toshiba Disk Products
3910 Freedom Circle Suite 103
Santa Clara, CA
408-727-3939

CD ROM drives

Technical Communications

Microsoft Press
16011 N. E. 36th
Box 97017
Redmond, WA 98073-9717

CD ROM: The New Papyrus, a reference work about compact discs and disc pressing issues

CD ROM: Optical Publishing, a reference work that explains the High Sierra format, and discusses compact disc publishing experiences

AppleCD SC Specifications

Physical

Depth	266 mm	(10.47 inches)
Width	246 mm	(9.69 inches)
Height	84 mm	(3.31 inches)
Weight	4.0 kg	(8.8 lbs)

General

Disc

Recording surfaces	1
Disc diameter	120 mm
Disc center hole	15 mm
Thickness	1.2 mm
Track pitch	1.6 microns (15,875 tracks per inch)
Scanning velocity	1.2 - 1.4 meters per second
Rotation speed	Varies over radius ~530 to 230 rpm
Latency (average)	~55 to 130 milliseconds
Blocks per rotation	~8.4 to 19.5 variable

Data

Data capacity	550 Mbytes, mode 1 630 Mbytes, mode 2
Number of blocks/disc	270,000
Data per block	2048 bytes, mode 1 2336 bytes, mode 2
Address description	Minutes, seconds, frames

Audio capacity

Playing time	1 hour
--------------	--------

Data streaming rate

Blocks per second	75 blocks per second
-------------------	----------------------

User bytes per second	153.6K, mode 1 175.2K, mode 2
-----------------------	----------------------------------

SCSI bus transfer rate	800K per second
------------------------	-----------------

Technical Communications

Modes supported

CD-ROM	modes 1 and 2
CD-Audio	

Environmental

Noise (maximum)	
Drive on (seek or non-seek)	<46 dB(A)

Temperature

Operating Temperature	+10 degrees C to +40 degrees C
Storage (6 months)	-30 degrees C to +50 degrees C
Transit (72 hours)	-30 degrees C to +55 degrees C

Humidity	Classified as Class 1 equipment
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Power requirements

AC Input (US and Canada)	120V AC $\pm$ 10%, 58 to 62 Hz
AC Input (Universal)	100/120/200/220/240V AC $\pm$ 10%, 48 to 62 Hz

Power Consumption	
Drive on	40 watts

Interface

SCSI expansion ports	50-pin connector
----------------------	------------------

Glossary of terms

CD-Audio Industry standard for compact disc player hardware, compact disc media, and level 1 error correction and detection. Also known as Red Book. Supported by AppleCD SC.

CD-I Compact Disc - Interactive. CPU proposal which includes a compact disc file structure definition. Also known as Green Book.

CD-ROM Compact Disc - Read Only Media. Defines data storage and error detection and correction on compact disk. Also known as Yellow Book. Supported by AppleCD SC.

CD-V Compact Disc - Video. Definition for full-motion video on NTSC. Supports 200 Mbytes of CD-ROM information and five minutes of full-motion video in Laserdisk format.

CLV Constant Linear Velocity. Used on storage devices (among them compact discs) to maintain one speed at which data passes by the head. Requires varying rotation speeds as radius of track changes.

CVD Compact Video Disc. Full-motion video definition from SOCS Research.

DVI Digital Video Interface. Definition for full hour of video on compact disc at 30 frames per second. Supports CD-ROM.

Green Book See CD-I.

High Sierra Hierarchical file structure definition for CD-ROM. CPU independent. Supported by AppleCD SC.

Land Flat area on inner surface of compact disc. Reflects laser light back to sensor. Represents data value "1".

Laser Light Amplification by Stimulated Emission of Radiation. Produces coherent light by exciting molecules of pure chemical substance.

Technical Communications

Mastering Process of creating the "golden" disc, which is then used to create copies for use in compact disc manufacture.

Optical media Any data storage device that operates using light to retrieve and/or write data to storage medium. Typically uses laser to produce light. Compact disc is one type of optical media.

Pit "Bump" on inner surface of compact disc. Scatters laser light. Represents data value "0".

Premastering Process of adding error detection and correction bytes to user data. Done prior to mastering disc.

Red Book See CD-Audio.

WORM Write Once - Read Many. Removable optical media which accept new data only once. Data can be read many times. Not compatible with compact discs.

Yellow Book See CD-ROM.

Lab Suggestions

- 1) Play an audio CD from either the Macintosh or the Apple IIe. Use CD Remote to program the disc to play songs in an order other than the default.
- 2) Open a file from the CD Test Disc. Note the speed of data access compared to a hard disk or floppy disk on the same system.
- 3) Try ejecting a disc using the hardware eject button under various circumstances (on an Apple II, on a Macintosh, with an audio CD)



Frostbyte Falls

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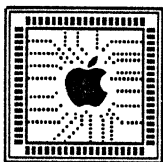
OVERHEADS



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UNIVERSITY OF CALIFORNIA





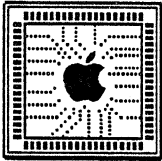
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Apple Computer, Inc. Technical Communications

AppleCD SC

- CD-ROM
(Compact Disc - Read Only Media)
- Audio capabilities
- SCSI ports
- Apple II and Macintosh support
- Formats supported:
 - CD-Audio
 - ProDOS
 - HFS
 - High Sierra
- Announce March 1

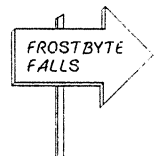
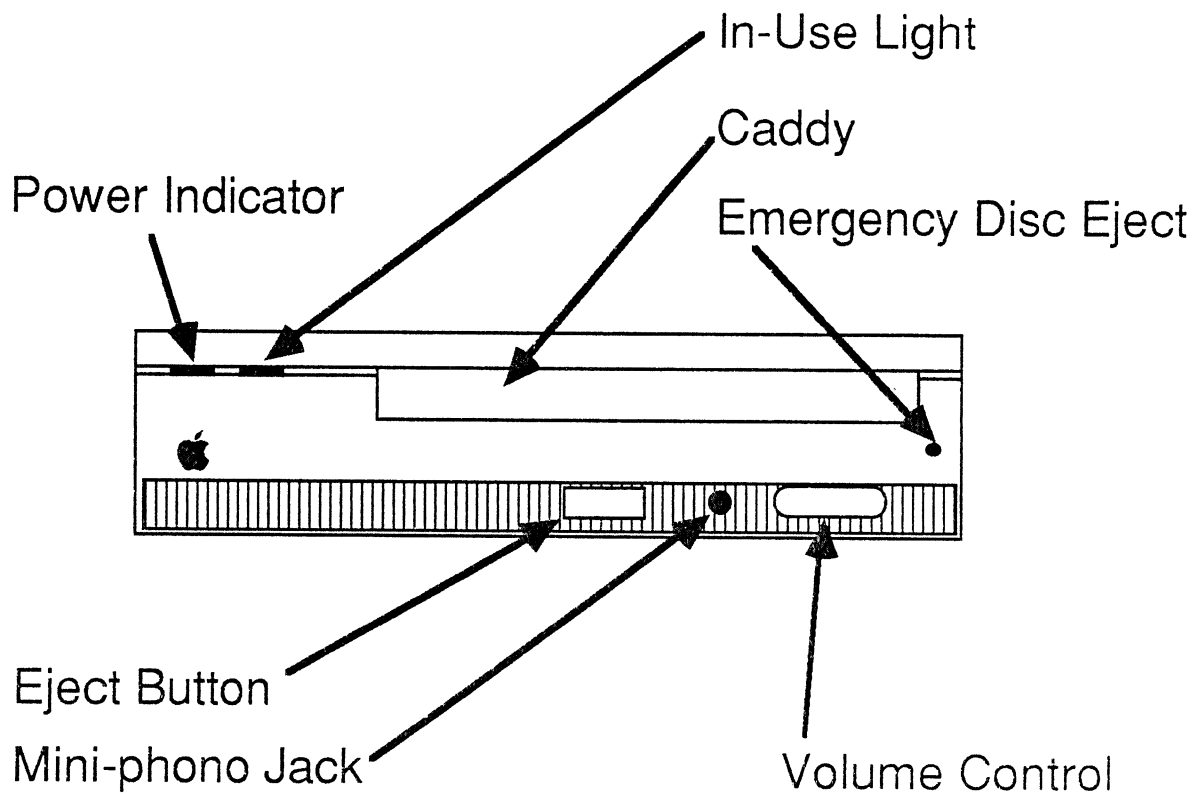




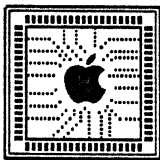
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AppleCD SC - Front View



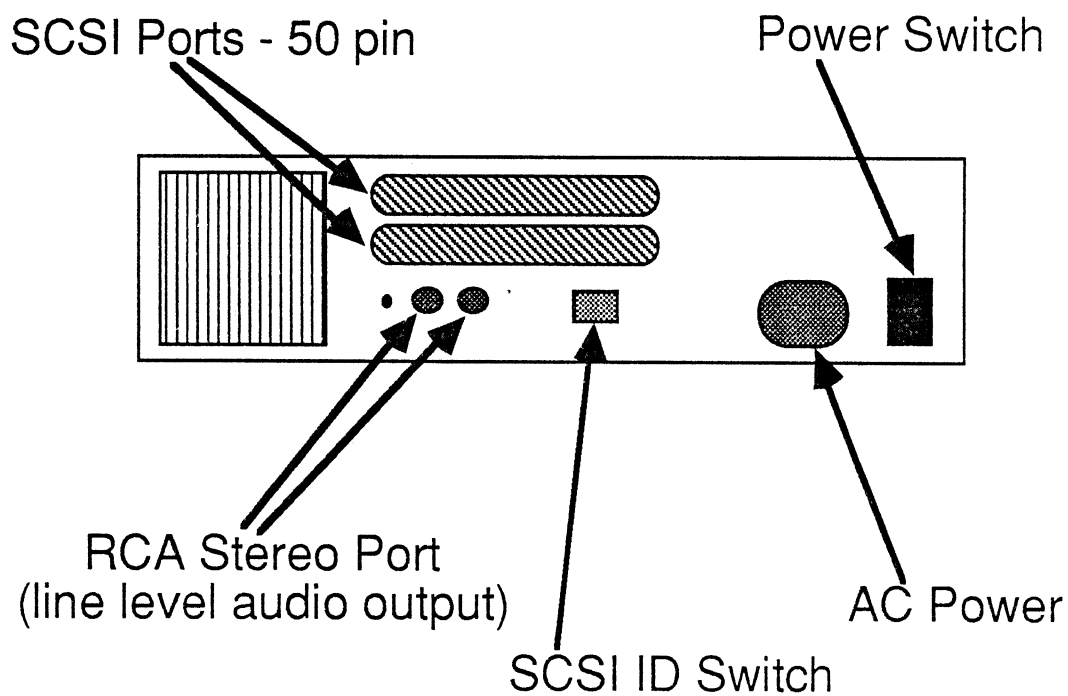
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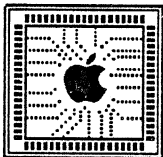
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AppleCD SC - Back View



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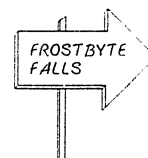


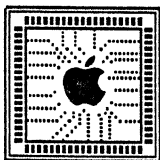
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CD-ROM Characteristics

- Read only media
- Over 550 MBytes data storage
 - 250,000 text pages
 - 20,000 line drawings
 - 2,000 high-resolution drawings
- Low-cost media duplication
- Sturdy media
 - Unaffected by magnets
- Removable media



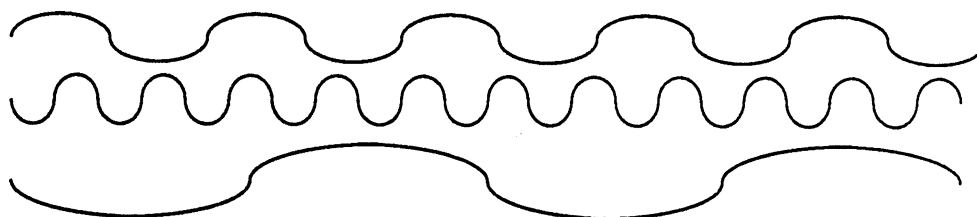


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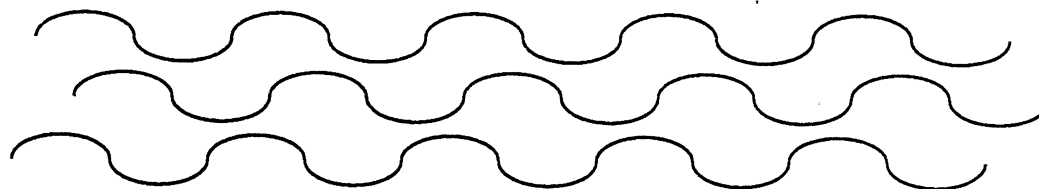
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Wavelengths of light

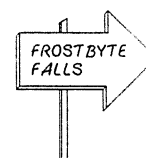
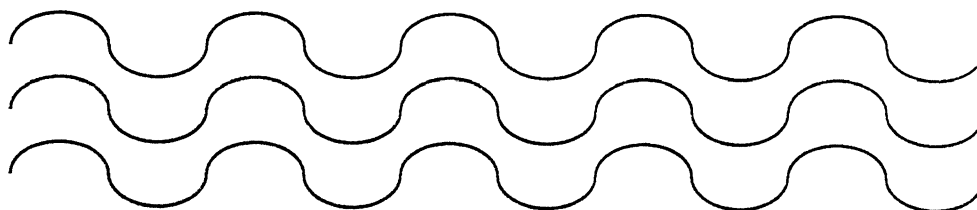
White light

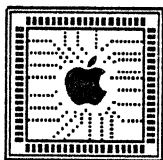


Light of a particular color



Laser (Coherent light)

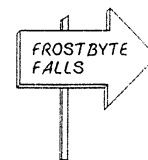
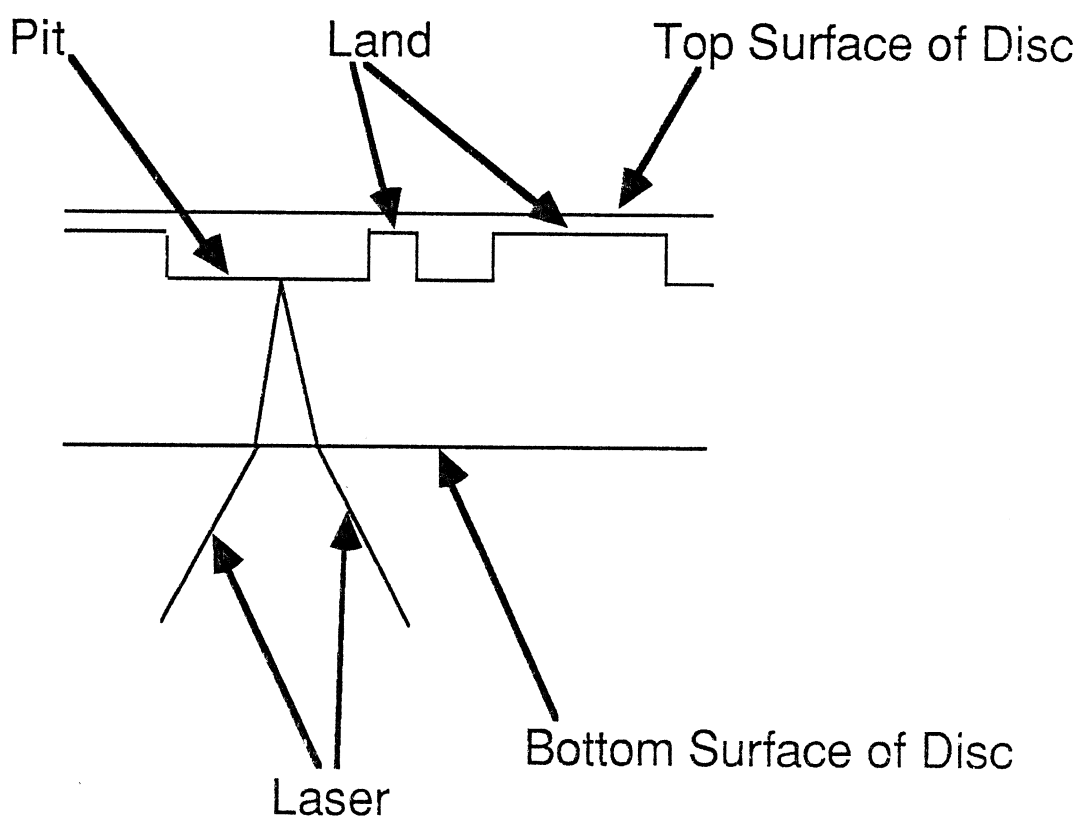




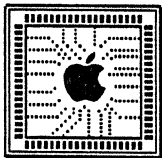
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Compact Disc Data Representation



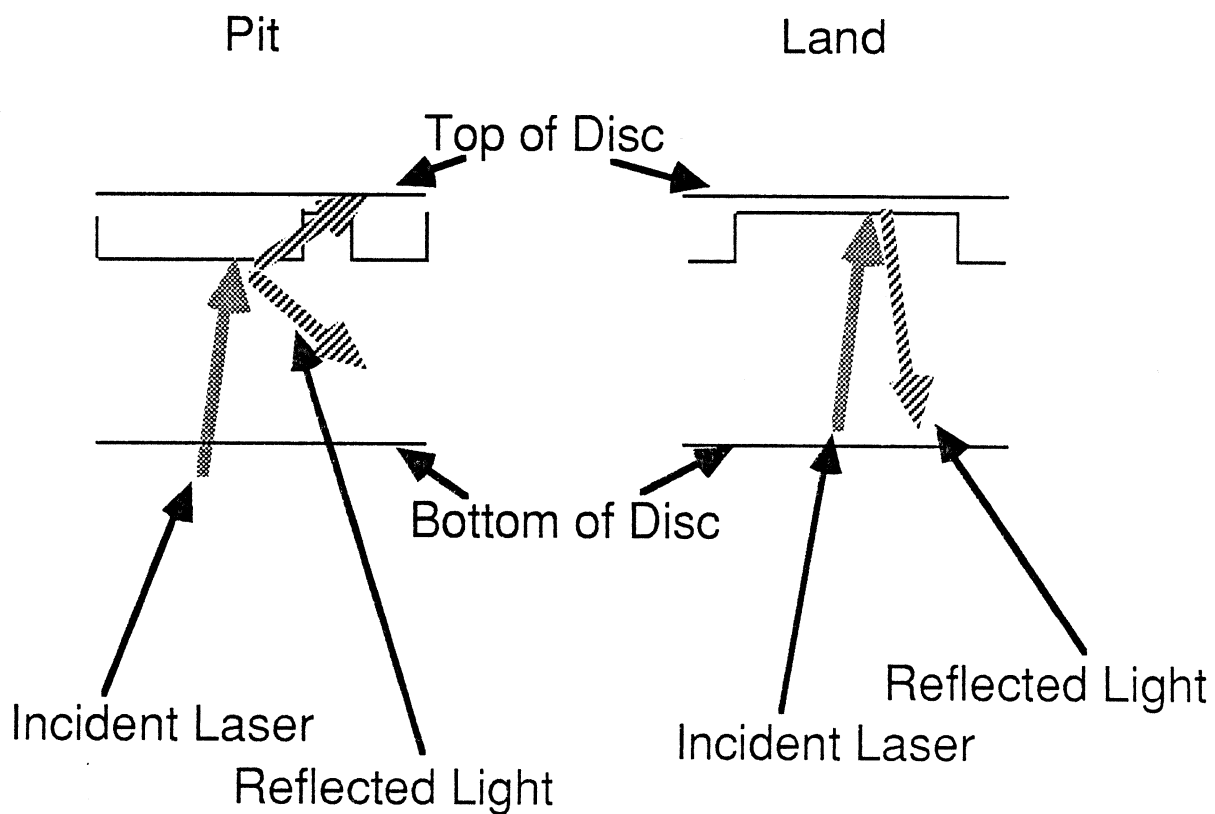
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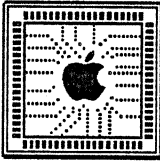


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Laser on Pits and Lands



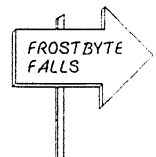


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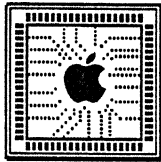
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Compact Disc Media

- Laser does not cross disc's label
- Data is protected from external damage
- One spiral track
- Uses Constant Linear Velocity



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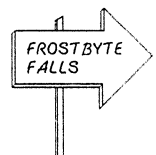


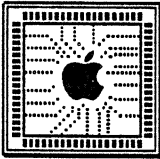
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Mass Storage Media

- CD-Audio
 - Same engine as CD-ROM
 - CD-ROM uses more error checking
- WORM Drives
 - Write Once Read Many
 - Different engine and media
 - Two-sided disks - one head
- Laserdisk
 - Stores analog video
 - Stores analog and digital sound
 - No digital data standard
- Hard Disks
 - Transfer rate 10 times CD

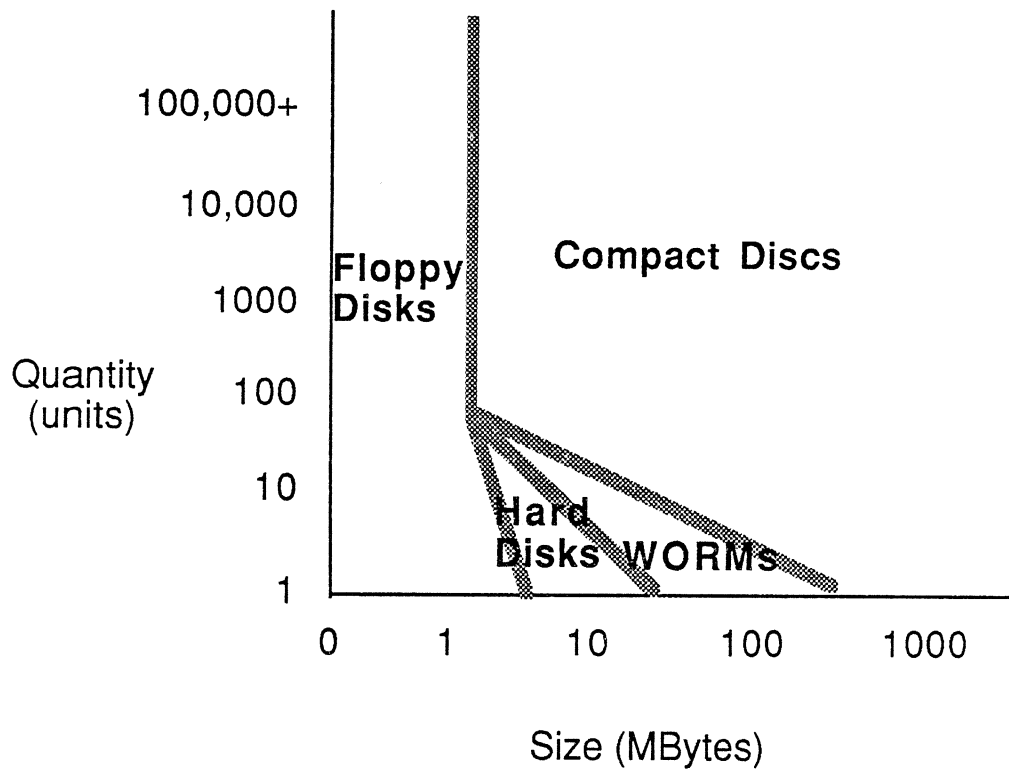




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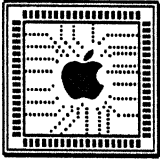
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Mass Storage Media Choices



	Capacity (bytes)	Cost for media(\$)	Cost/ MByte (\$)
CD-ROM	550 M	5.00	0.01
Hard Disk	80M	1000.00	12.50
Floppy Disk	800K	2.00	2.50
WORM	800M	100.00	0.13





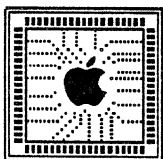
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Preparing a CD-ROM

- Collect and Organize Data
 - Test data and organization
 - CD Publisher from Meridian Data
- Premaster
 - Add error detection and correction
 - Copy data onto acceptable medium
- Master
 - Create glass master
 - Produce stampers
- Press Discs
 - Add spattering
 - Add label





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Mastering Discs

Master



- Made of glass
- Etched with photoresist

Mother



- Made of nickel

Daughter



- Made of nickel

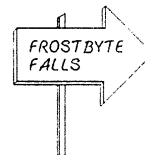
Stamper



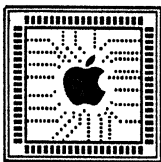
Compact Disc



- Polycarbonate



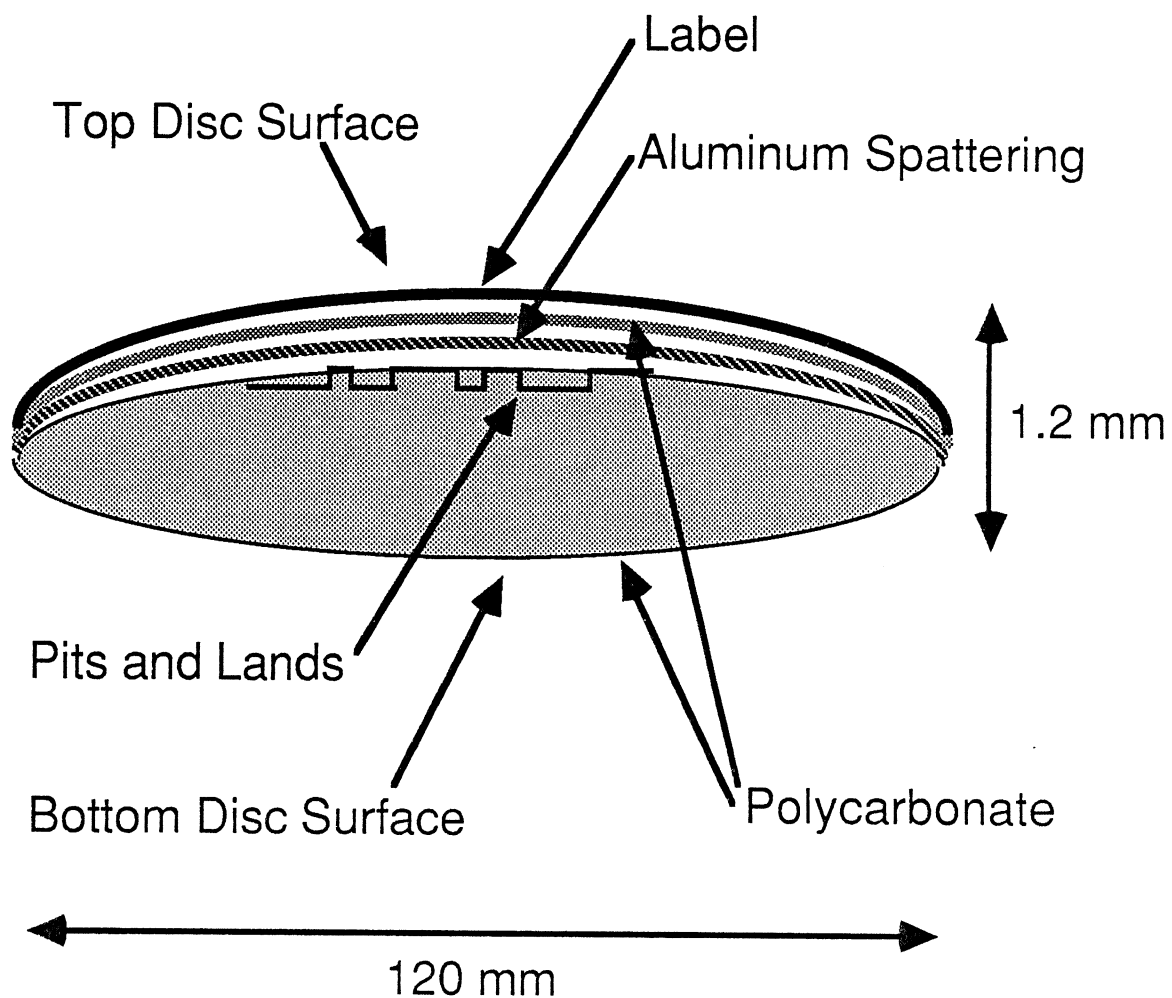
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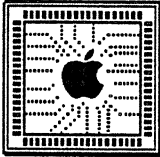
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Compact Disc Cross Section



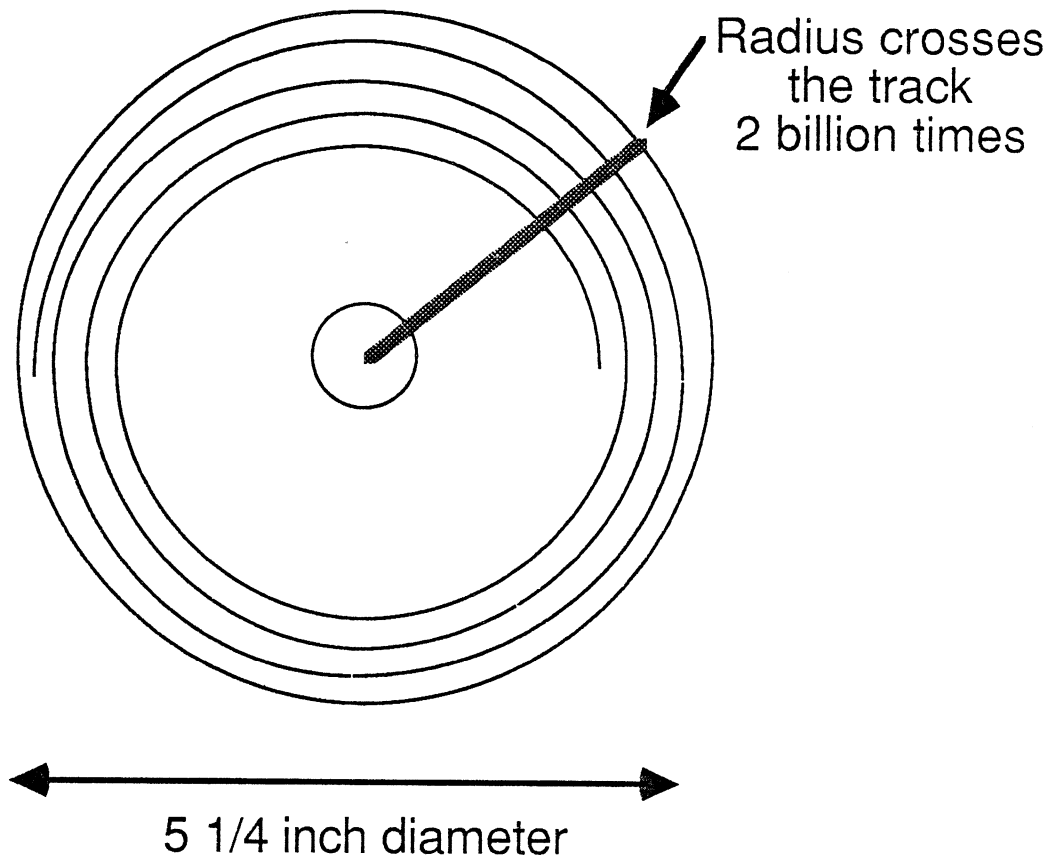
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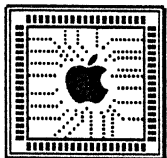
Compact Disk Track



- Each path is 0.6 microns wide
- 1.6 microns between paths
- Track is 3 miles long



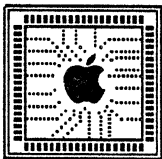
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Compact Disc Formats

- Red Book : CD-Audio
 - Defines Compact Disk - Audio
 - Defines physical characteristics
 - Includes CIRC error correction
- Yellow Book : CD-ROM
 - Defines data organization
 - Additional error correction
- High Sierra
 - CD-ROM hierarchical file format
 - CPU independent
 - Written for slow, read-only media
- Others
 - Green Book : CD-I
 - Proposed file structure for new CPU
 - Compact Disk - Video (CD-V)
 - Digital Video Interface (DVI)
 - Compact Video Disc (CVD)

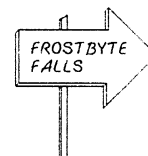
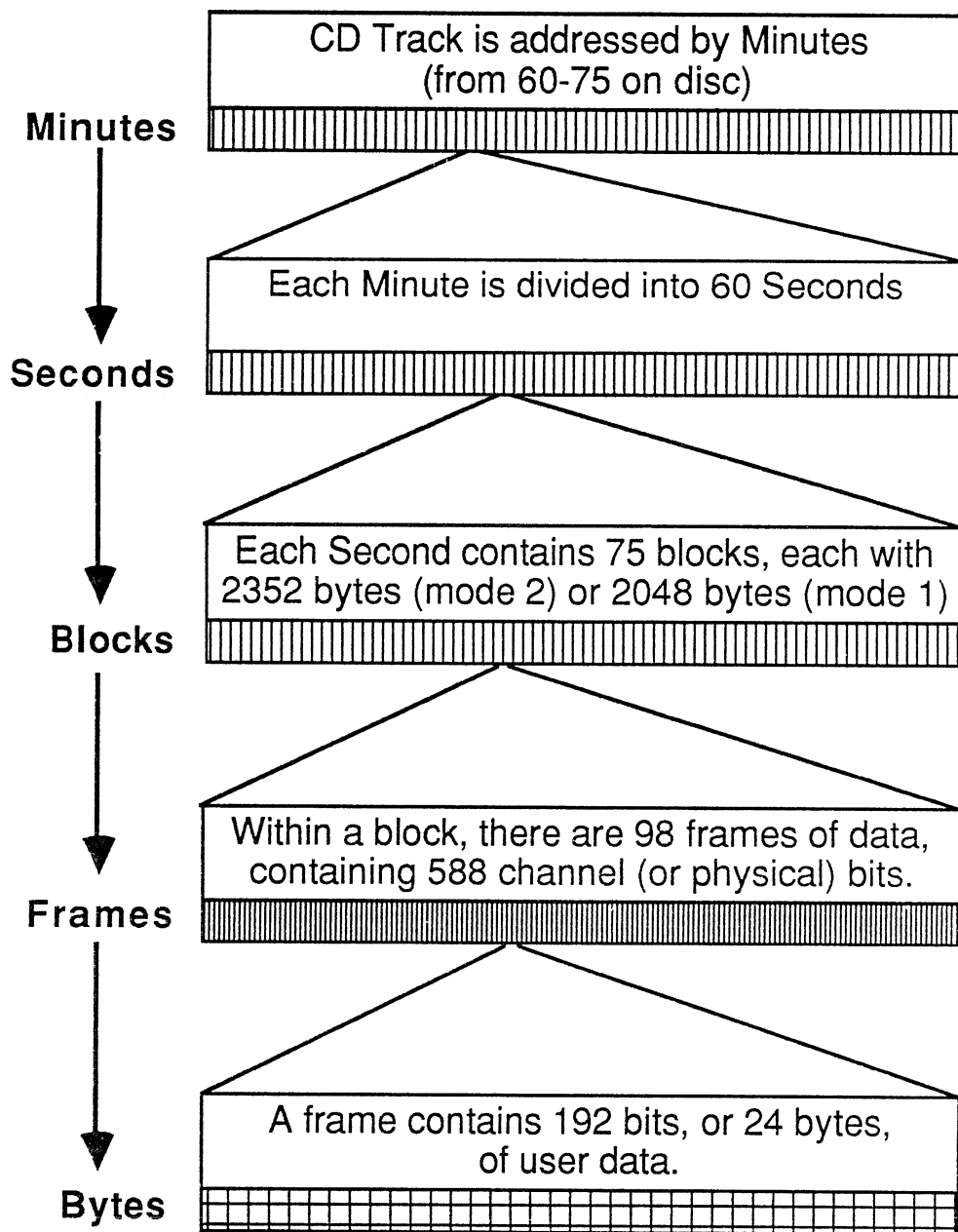




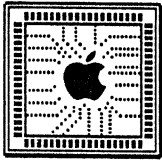
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CD-ROM Data Organization



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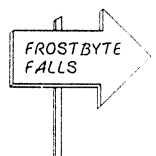


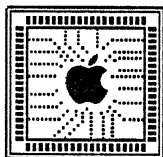
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AppleCD SC Features

- Access time - 500 milliseconds
- Transfer rate - 154 KBytes per second
- Recognizes mode 1, mode 2, and audio
- Includes 64K RAM buffer
- Designed for heavy random access
- Includes SCSI ports and controller





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The AppleCD SC on an Apple II

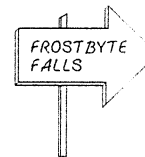
- Requires rev C ROM on SCSI Card
- Connect CD to end of SCSI bus
- Eject button operational
- Audio discs

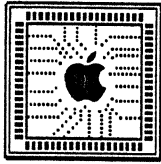
Use CD.AUDIO desk acc on IIGS
Use CD Remote application on //e

- ProDOS discs
- No special software needed
- High Sierra discs

Incorporate driver into ProDOS 8 application
Add driver to folder under ProDOS 16

- 64K buffer helpful on Apple //e



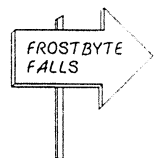


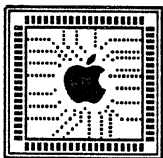
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The AppleCD SC on a Macintosh

- Connect CD to SCSI bus
- Add resource and INIT to System Folder
- Audio discs
 - Use CD Remote desk accessory
 - Eject button works
- HFS discs
 - Icon appears on desktop
 - Eject button doesn't work
- High Sierra discs
 - Requires External File System (XFS)
 - Place High Sierra driver in System Folder
 - Eject button will not work on ANY disc
- Speed "slow" on Macintosh SE and II



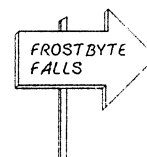


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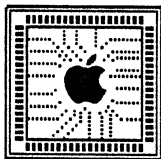
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What comes with the AppleCD SC?

- Compact disc player
- One disc caddy
- ProDOS 3.5" disk
- Macintosh disk
- (Later) - sample CD



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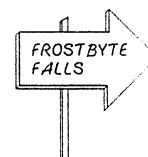


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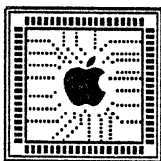
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Applications with a CD

- Known as "retrieval engines"
- Full-text search
- Hypermedia
- Query language
- HyperCard - new version



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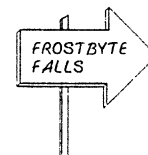
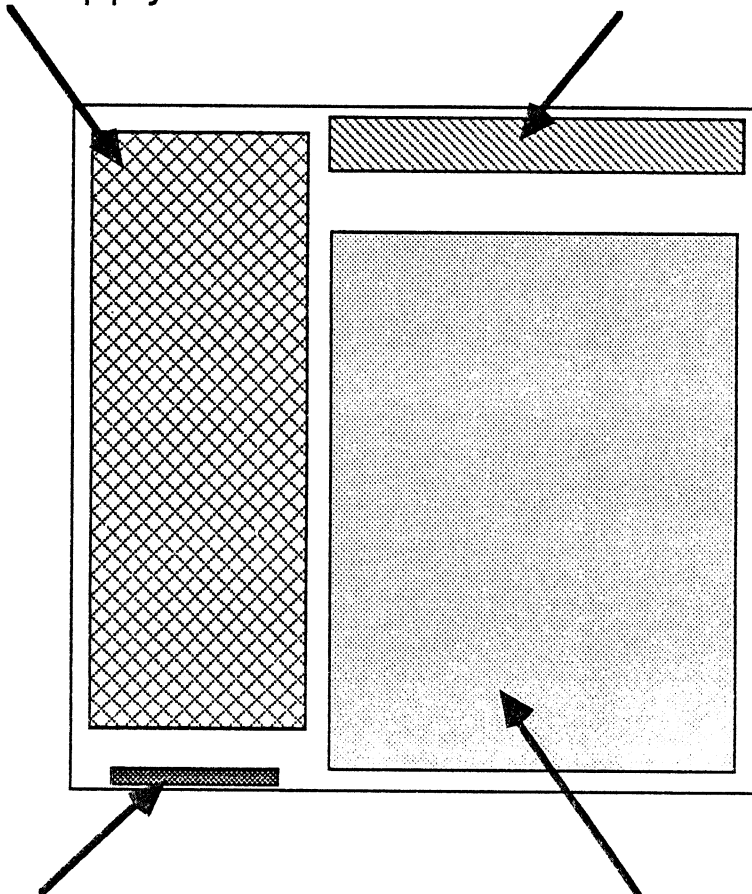
Inside the AppleCD SC Top View

Power Supply

External Ports

Indicator Lights

Compact Disc Assembly



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